Internship Program Report

By

MODUGUMUDI HARIKA - 19485A0218

GUDLAVALLERU ENGINEERING COLLEGE
(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)
(Sponsored by A. A. N. M & V. V. R. S. R Educational Society, Gudlavalleru)
Approved by AICTE, New Delhi and Permitted by AP State Government
Accredited by NAAC with 'A' Grade
Counselling Code : GDLV

In association with

Smart Internz

Contents

Introduction

Internship program arranged by GUDLAVALLERU ENGINEERING COLLEGE in association with Smart Internz, Hyderabad for the benefit of 3rd /4th year EEE batch 2018-2022 on Electrical Detailed design Engineering for Oil& Gas, Power and Utility industrial sectors.

Program organiser

Smart Bridge, Hyderabad.

Pioneer in organising Internships, knowledge workshops, debates, hackathons, Technical sessions and Industrial Automation projects.

Courtesy

Dr. Sri B. Dasu – HOD – EEE, GEC

Mr. Rama Krishna –

Mr. Ramesh V - Mentor

Mr. Vinay Kumar - System Support

Mr. Harikanth – Softwar/Technical Support

Program details

Smart Internz program schedule: 4 weeks starting from 3rd May 2021

Daily schedule time shall be 4PM to 6.30PM

Mode of Classes: On line through ZOOM

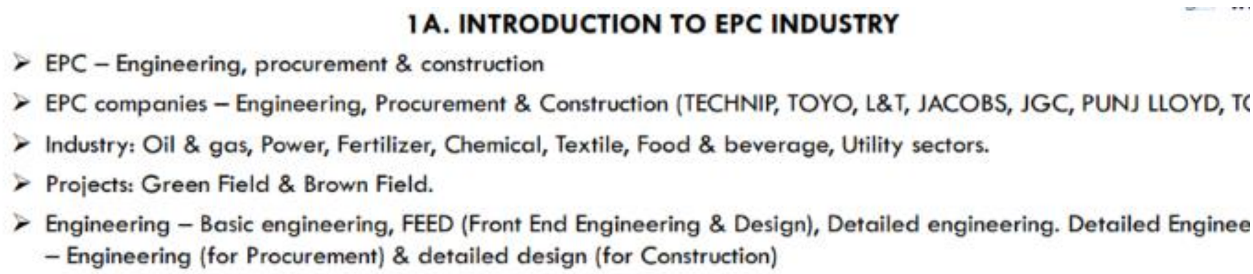
Presenter: Mr Ramesh V

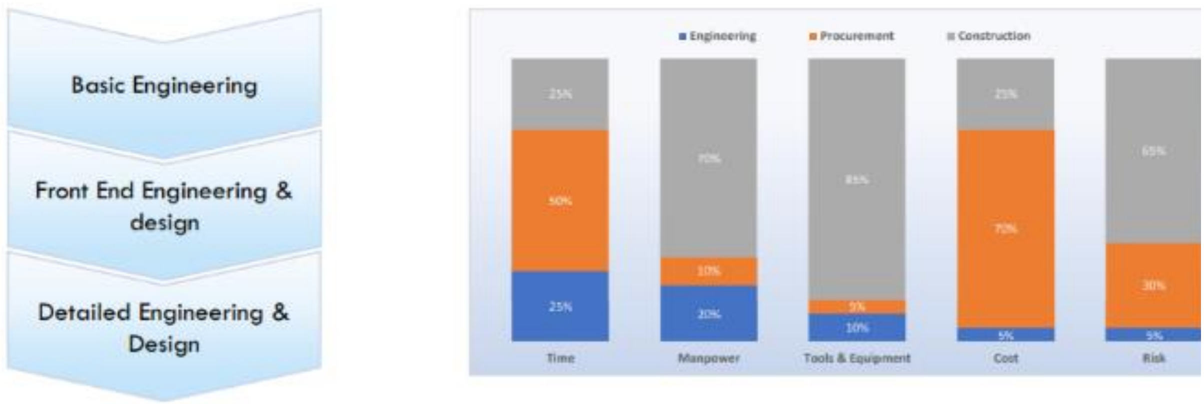
Internship program

We have been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design engineering for various industrial sectors.

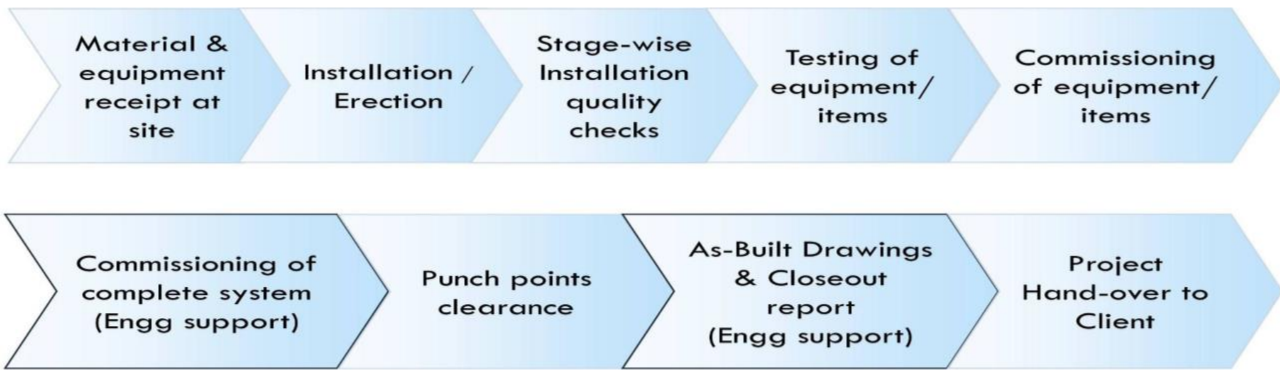
3rd May2021: Introduction to EPC Industry

1	EPC Industry & Electrical Detailed Engineering	EPC Industry	Introduction
		Engineering	Types of Engineering
		Procurement	Engineering role in procurement
		Construction	Engineering role during construction





Engineering support to construction



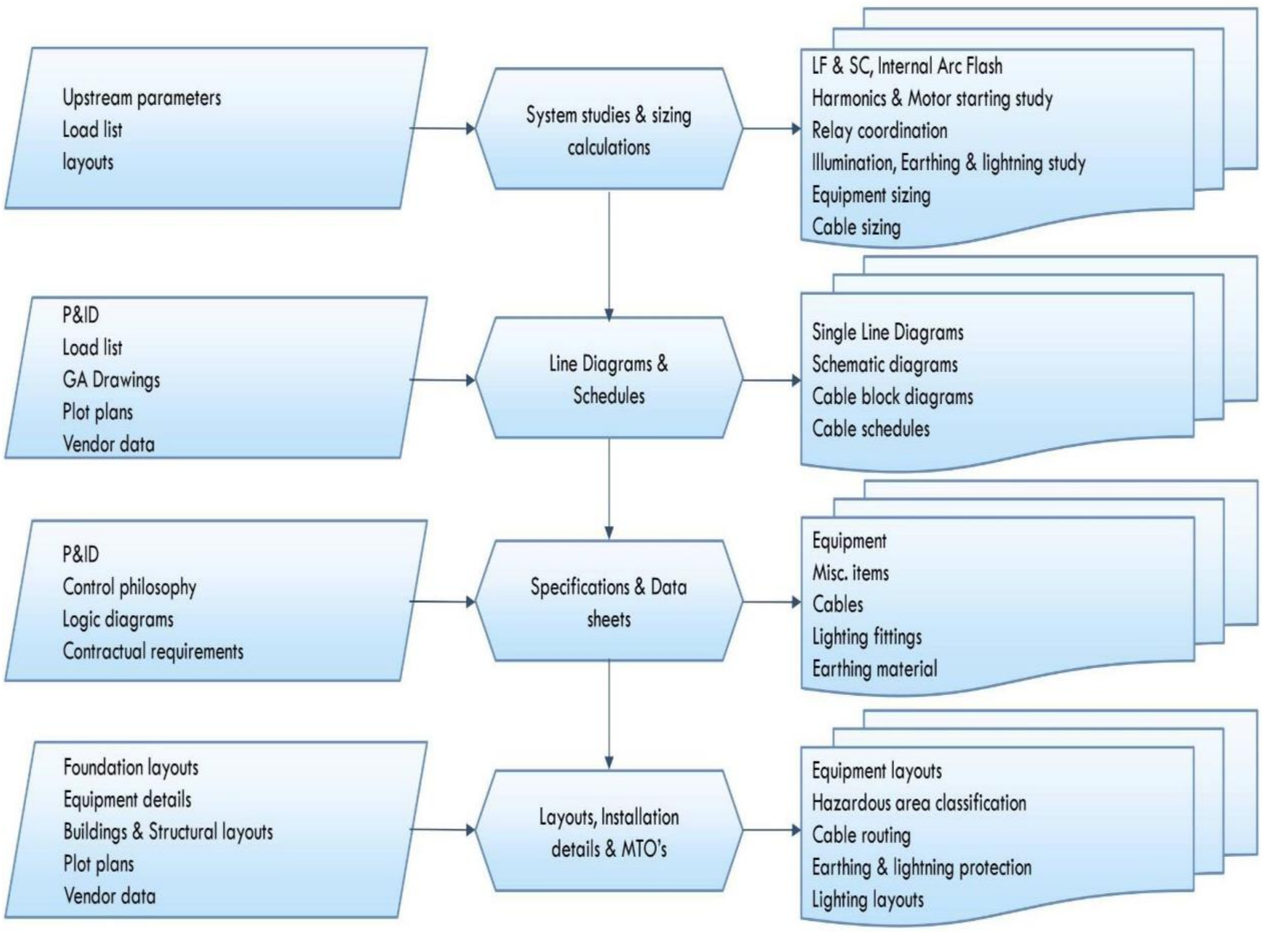
In this session we learnt about Engineering phases, Engineering deliverables (drawings & documents) list, Design Engineer role at various phases of project.

4th May2021: Engineering documentation for EPC projects

2	Electrical Design Documentation	Engineering Deliverables list	Sequence of deliverables
		Detailed Engineering work flow	Detailed engineering process
		Document transmission	Document submission and infoexchange
		Deliverables types	Different types of deliverables

Topic details: types of deliverables,

Sequence of deliverables:



On this day we learned about types of electrical detailed engineering deliverables, sequence of deliverables and information exchange related to project and technical works. Also gone through some important electrical terminologies and abbreviations.

5th May2021: Engineering documentation for commands and formulae

3	Electrical Design Documentation	Ms word commands	Shortcut keys and function keys
		Ms excel formulae	Basic functions with example
		Auto cad basic commands	standard keys, modifier keys

Topic details: MS Word, Excel and Auto cad COMMANDS.

On this day we have seen some basic commands of MS WORD, MS EXCEL and also about AUTO CAD basic functions and principles to draw the sketches of power plants.

Word Shortcut Keys

Command Name	Keys
All Caps	Ctrl+Shift+A
Apply List Bullet	Ctrl+Shift+L
Auto Format	Alt+Ctrl+K
Auto Text	F3
Bold	Ctrl+B
Cancel	ESC
Center Para	Ctrl+E
Change Case	Shift+F3
Clear	Del
Close or Exit	Alt+F4
Copy	Ctrl+C
Create Auto Text	Alt+F3
Cut	Ctrl+X
Double Underline	Ctrl+Shift+D
Find	Ctrl+F
Help	F1
Hyperlink	Ctrl+K
Indent	Ctrl+M
Italic	Ctrl+I
Justify Para	Ctrl+J
Merge Field	Alt+Shift+F
New Document	Ctrl+N
Open	Ctrl+O
Outline	Alt+Ctrl+O
Overtype	Insert
Page	Alt+Ctrl+P
Page Break	Ctrl+Return
Paste	Ctrl+V
Paste Format	Ctrl+Shift+V
Print	Ctrl+P
Print Preview	Ctrl+F2
Redo	Alt+Shift+Backspace
Redo or Repeat	Ctrl+Y
Save	Ctrl+S
Select All	Ctrl+A
Small Caps	Ctrl+Shift+K
Style	Ctrl+Shift+S
Subscript	Ctrl+=
Superscript	Ctrl+Shift+=
Task Pane	Ctrl+F1
Time Field	Alt+Shift+T

Excel Formulas

Basic math

Function	Formula	Example
To add up the total	=SUM(cell range)	=SUM(B2:B9)
To add individual items	=Value1 + Value 2	=B2+C2
Subtract	=Value1 - Value 2	=B2-C2
Multiply	=Value1 * Value2	=B2*C2
Divide	=Value1 / Value2	=B2/C2
Exponents	=Value1 ^ Value2	=B2^C2
Average	=AVERAGE(cell range)	=AVERAGE(B2:B9)
Median	=MEDIAN(cell range)	=MEDIAN(B2:B9)
Max	=MAX(cell range)	=MAX(B2:B9)
Min	=MIN(cell range)	=MIN(B2:B9)

Simple formatting tricks

Function	Formula	Example
To change a cell to proper case	=PROPER(cell)	=PROPER(A2)
To change a cell to upper case	=UPPER(cell)	=UPPER(A2)
To change a cell to lower case	=LOWER(cell)	=LOWER(A2)

Conditional statements

Function	Formula	Example
If statement	=IF(logical test, "result if the test answer is true", "result if the test answer is false")	=IF(B2>69,"Pass","Fail")
Exact	=EXACT(Value1, value2)	=EXACT(B2, C2)

Absolute cell references

When a formula contains an absolute reference, no matter which cell the formula occupies the cell reference does not change: if you copy or move the formula, it refers to the same cell as it did in its original location. In an absolute reference, each part of the reference (the letter that refers to the row and the number that refers to the column) is preceded by a "$" – for example, **$A$1** is an absolute reference to cell A1. Wherever the formula is copied or moved, it always refers to cell A1.

AUTOCAD BASIC KEYS

STANDARD		DRAW		MODIFY		FORMAT	
NEW	Ctrl+N	LINE	L	ERASE	E	PROPERTIES	MO
OPEN	Ctrl+O	RAY	RAY	COPY	CO	SELECT COLOR	COL
SAVE	Ctrl+S	PLINE	PL	MIRROR	MI	LAYER	LA
PLOT	Ctrl+P	3DPOLY	3P	OFFSET	O	LINETYPE	LT
PLOT PREVIEW	PRE	POLIGONE	POL	ARRAY	AR	LINEWEIGHTS	LW
CUT	Ctrl+X	RECTANGLE	REC	MOVE	M	LT SCALE	LTS
COPY	Ctrl+C	ARC	A	ROTATE	RO	LIST	LI
PASTE	Ctrl+V	CIRCLE	C	SCALE	SC	DIMEN. STYLE	D
MATCH PROPE.	MA	SPLINE	SPL	STRECH	S	RENAME	REN
CLOSE	Ctrl+F4	ELLIPSE	EL	TRIM	TR	OPTION	OP
EXIT	Ctrl+Q	BLOCK	B	EXTENED	EX		
		POINT	PO	BRAKE	BR		
		HATCH	H	CHAMFER	CHA		
		GRADIENT	GD	FILLET	F		
		REGION	REG	EXPLODE	X		
		BOUNDARY	BO				
		DONUT	DO				

EXTRA				DRAFTING		PAPER SIZE
UNIT	UN	UCS	UCS	ORTHO	F8, Ctrl+L	A4=210*297
LIMITS	LIMITS	SINGLE TEXT	DT	OSNAP	F3, Ctrl+F	A3=297*420
(0,0; 1000,1000)		MULTILINE TEXT	MT	POLAR	F10, Ctrl+U	A2=420*594
ZOOM	Z	EDIT TEXT	ED	GRID	F7, Ctrl+G	A1=594*841
ALL	A	OBJECT SNAP	OB	OTRACK	F11	A0=841*1189
PAN	P	DIMENTION	DIM	SNAP	F9	
CLEAN SCREEN	Ctrl+0	HORIZONTAL	HOR			
COMMAMD WIN	Ctrl+9	VERTICAL	VER			

10th May2021: Engineering documentation for Electrical system design.

4	Electrical system design for typical diagrams	Load lists/schedule	Power flow diagram
		Single line diagram	Typical schematic diagram

Topic details: Typical diagrams and Load calculations.

We conclude here how to do load calculations and Typical diagrams and internal structure and also about the power flow diagram.

LOAD LIST /SCHEDULE:

S.No	EQUIPMENT Equipment No.	Description	Supply by :-	Vital	Essential	Non essential	Restarting	Absorbed load A (kW)	Equipment rating B (kW)	Load factor =A/B or H/I C (In decimals)	Efficiency at load factor C D (In decimals)	Power factor at load factor C (Cos φ)	Consumed Load (kW = A/D; kVAr = kW*tan j) Continuous E No.	Continuous kW	Continuous kVAr	Intermittent and spares F No.	Intermittent kW	Intermittent kVAr	Stand-by G No.	Stand-by kW	Stand-by kVAr	Remarks	Revision
	PROCESS LOADS																						
1	PD-3431	Portable MEG Injection Pump Package	LEWA			x		27.00	37.00	0.73	0.91	0.83				1	29.67	19.94				Portable Skid (Please refer Note-d)	B
2	34-PM8401A	Liquid Return Pump Motor	LEWA			x		25.45	31.00	0.82	0.93	0.81				1	27.37	19.81					01
3	34-PM8401B	Liquid Return Pump Motor	LEWA			x		25.45	31.00	0.82	0.93	0.81							1	27.37	19.81		01
4	34-PM8402A	Booster Pump Motor (LRP Package)	LEWA			x		1.40	2.20	0.64	0.78	0.84				1	1.79	1.16					01
5	34-PM8402B	Booster Pump Motor (LRP Package)	LEWA			x		1.40	2.20	0.64	0.78	0.84							1	1.79	1.16		01
6	34-PM7902A	Corrosion Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77	1	7.17	5.94								01
7	34-PM7902B	Corrosion Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77							1	7.17	5.94		01
8	34-PM7903A	Batch Corrosion Inhibitor Injection Pump Motor	RAM			x		133.50	160.00	0.83	0.96	0.80							1	139.06	104.30		01
9	34-PM7903B	Batch Corrosion Inhibitor Injection Pump Motor	RAM			x		133.50	160.00	0.83	0.96	0.80							1	139.06	104.30		01
10	34-PM7904A	KHI Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77	1	7.17	5.94							VSD for speed control	B
11	34-PM7904B	KHI Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77							1	7.17	5.94	VSD for speed control	B
12	34-PM7905A	Scale Inhibitor Injection Pump Motor	FUTURE			x		3.00	4.00	0.75	0.85	0.81	1	3.53	2.56							Future	B
13	34-PM7905B	Scale Inhibitor Injection Pump Motor	FUTURE			x		3.00	4.00	0.75	0.85	0.81							1	3.53	2.56	Future	B
14	34-KM9602A	Nitrogen Compressor Motor	GENERON			x		30.00	37.50	0.80	0.90	0.80	1	33.33	25.00								01
15	34-KM9602B	Nitrogen Compressor Motor	GENERON			x		30.00	37.50	0.80	0.90	0.80	1	33.33	25.00								01
16	34-KM9602C	Nitrogen Compressor Motor	GENERON			x		30.00	37.50	0.80	0.90	0.80							1	33.33	25.00		01
17	34-EM9602A	Aftercooler for Nitrogen Compressor	GENERON			x		1.15	2.50	0.46	0.78	0.80				1	1.47	1.11					01
18	34-EM9602B	Aftercooler for Nitrogen Compressor	GENERON			x		1.15	2.50	0.46	0.78	0.80				1	1.47	1.11					01
19	34-EM9602C	Aftercooler for Nitrogen Compressor	GENERON			x		1.15	2.50	0.46	0.80	0.80							1	1.44	1.08		01
20	34-H9602	Nitrogen Heater						6.20	1.00	6.20	0.90	1.00											01
21	34-PM9701A	Hydraulic Fluid Pump - Wellhead HPU - Very High Pressure	FRAMES			x		0.19	0.55	0.35	0.80	0.70				1	0.24	0.24					B
22	34-PM9701B	Hydraulic Fluid Pump - Wellhead HPU - Very High Pressure	FRAMES			x		0.19	0.55	0.35	0.80	0.70				1	0.24	0.24					B
23	34-PM9702A	Hydraulic Fluid Pump - Wellhead HPU - Medium High Pressure	FRAMES			x		5.80	7.50	0.77	0.80	0.86				1	7.25	4.30					B
24	34-PM9702B	Hydraulic Fluid Pump - Wellhead HPU - Medium High Pressure	FRAMES			x		5.80	7.50	0.77	0.80	0.86				1	7.25	4.30					B
25	34-A9704A	Hydraulic Fluid Pump -IOPPS Valves HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
26	34-A9704B	Hydraulic Fluid Pump -IOPPS Valves HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
27	34-PM9705A	Hydraulic Fluid Pump - ESDV's HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
28	34-PM9705B	Hydraulic Fluid Pump - ESDV's HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
29	AC-3435	Crane motor	LIEBHERR			x		112.00	140.00	0.80	0.95	0.90				1	117.89	57.10					01
30	34-XZM8303	Lifeboat Recovery Starter Panel	SCHAT HARDING			x		8.74	9.39	0.93	0.91	0.82							1	9.60	6.70		01
31	CP34302	Flare Knock Out Drum Heater Control Panel	CHROMALOX			x		35.00	35.00	1.00	0.90	0.90				1	38.89	18.83					01
	HVAC LOADS																						
32	34-YH4201ACCU01	Air Cooled Condensing Unit - 01	CCTC		x			37.25	42.90	0.87	0.82	0.80	1	45.43	34.07								01
33	34-YH4201ACCU02	Air Cooled Condensing Unit - 02	CCTC		x			37.25	60.00	0.62	0.82	0.80							1	45.43	34.07		01
34	34-YH4201AHU01	Air Handling Unit - 01	CCTC		x			8.85	10.00	0.89	0.80	0.80	1	11.06	8.30								01
35	34-YH4201AHU02	Air Handling Unit - 02	CCTC		x			8.85	10.00	0.89	0.80	0.80							1	11.06	8.30		01
36	34-YH4201FF01	Fresh Air Fan - 01	CCTC		x			8.00	8.00	1.00	0.90	0.80	1	8.89	6.67								01
37	34-YH4201FF02	Fresh Air Fan - 02	CCTC		x			8.00	8.00	1.00	0.90	0.80							1	8.89	6.67		01
38	34-YH4201EF01	Exhaust Fan - Toilet	CCTC		x			1.00	1.00	1.00	0.90	0.80				1	1.11	0.83					01
39	34-YH4201EDH01	Duct heater - 01	CCTC		x			9.78	9.78	1.00	1.00	1.00				1	9.78	0.00					01
40	34-YH4201EDH02	Duct heater - 02	CCTC		x			4.69	4.69	1.00	1.00	1.00				1	4.69	0.00					01
41	34-YH4201EDH03	Duct heater - 03	CCTC		x			0.90	0.90	1.00	1.00	1.00				1	0.90	0.00					01
42	34-YH4201EDH04	Duct heater - 04	CCTC		x			4.98	4.98	1.00	1.00	1.00				1	4.98	0.00					01
	ELECTRICAL LOADS																						
43	AC-3431	Power Distribution Board	MASSEERA		x			41.00	51.50	0.80	0.98	0.80	1	41.84	31.38							Inclusive of MOV, Choke valve, Control valve and heat tracing loads	00
44	UPS-3441/3442/3443	UPS- Main/Bypass	GUTOR		x			24.00	24.00	1.00	0.82	0.80	1	29.27	21.95								B
45	BC-3442	Switchgear 24 V DC UPS	SAFT		x			1.20	1.20	1.00	0.80	0.80	1	1.50	1.13								00
46	LTR-3431	Lighting Transformer for LP-3431	SCHNEIDER		x			27.00	27.00	1.00	0.98	0.90	1	27.55	13.34							Inclusive of lighting load, convenience outlets and small power loads.	B
47	ELTR-3431	Lighting Transformer for ELP-3431	SCHNEIDER		x			27.00	27.00	1.00	0.98	0.90	1	27.55	13.34							Inclusive of lighting load, convenience outlets and small power loads.	B
48	WD-3431A	Welding Socket Outlet 1 - Upper Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
49	WD-3431B	Welding Socket Outlet 2 - Upper Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
50	WD-3432A	Welding Socket Outlet 1 - Lower Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
51	WD-3432B	Welding Socket Outlet 2 - Lower Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
52	WD-3433A	Welding Socket Outlet 1 - Mezz Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
53	WD-3433B	Welding Socket Outlet 2 - Mezz Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
54	WD-3434	Welding Socket Outlet - Cellar Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
											TOTAL			278	195		252	125		671	503		
											$kVA = \sqrt{(kW^2 + kVAr^2)}$			339			282			838			

Max. of normal running plant load: (Est. x %E + y %F) 353 kW, 232 kVAr, $\sqrt{(kW^2 + kVAr^2)}$ 423 kVA

Peak load: (Est. x %E + y %F + z%G) 420 kW, 282 kVAr, $\sqrt{(kW^2 + kVAr^2)}$ 506 kVA

x = 100, y = 30, z = 10

Power factor without compensation [Cos φ] 0.836

Power factor with compensation [Cos φ_1]

Reqd capacitor rat: [=kW(tan φ - tan φ_1)] kVAr

Notes -

a) **Load classification/restarting:** For definitions of "Vital", "Essential" and Non - Essential", services and application of "Restarting", see DEP 33.64.10.10 - Gen. Electrical engineering guidelines.

b) **Absorbed loads:**
- for pumps, shaft load on duty point.
- for instrumentation, computers, communication, & air condit'g, the required load during full operation of plant.
- for lighting, during dark hours.
- for workshops, the average total load in normal full operation.

c) Consumed loads:

E - "Continuous"; all loads that may continuously be required for normal operation operation including lighting and workshops

F - "Intermittent and spares"; the loads required for intermediate pumping, storage, loading, etc, and all electrical spares of electrically driven units.

G - "Stand - by"; loads required in emergencies only, such as fire water pumps or those of not normally running electrically driven units & electrical stand - by for normally running steam - driven ones (e.g.charge pumps, boiler feed pumps)

d) The Panel shall feed Injection Pumps P7901A/B.

e) Batch Injection pump considered as standby load during normal running condition based on operating philosophy.

QATARGAS 3&4
OFFSHORE FACILITIES PROJECT
WELLHEAD PLATFORM 7

J. RAY McDERMOTT

REVISION	DATE	PREPARED BY	DESCRIPTION OF REVISION
01	24-Jun-07	AK	APPROVED FOR CONSTRUCTION
00	22-Aug-07	PJ	APPROVED FOR CONSTRUCTION WITH HOLD
B	18-Jul-07	PJ	ISSUED FOR COMPANY REVIEW
A	26-Oct-06	JG	ISSUED FOR IDC

11th May2021: Classification of Transformers and Generators.

5	Classification of Transformers and Generators	Different types of Transformers	Applications of transformers
		Diesel generator sets	Applications & sizing of DG set

Topic details: Classification of Transformers and Generators.

Different types of transformers and generators:

1 Ph. Pad mounted Residential lighting

3 Ph Pole mounted Commercial/ Residential/ street lighting

3 Ph Oil filled (ONAN) Distribution type for industrial & commercial

3 Ph Oil filled (ONAF) Power transformer for industrial

3 Ph. Auto transformer for large motor starting & line regulation

3 Ph. Servo Stabilizer for hospital and critical equipment

3 Ph. Dry type indoor for commercial/industrial/data centers

- APPLICATIONS

Typical application of Prime Power DG Set: where the generator is the sole source of power for say a remote mining or construction site, remote military locations etc.

Mining, Healthcare, Commercial, Oil & gas, Construction, manufacturing, Telecommunication, Data Centers, Education, Military etc.

11kV/6.6kV Diesel generator sets for standby / Emergency power supply

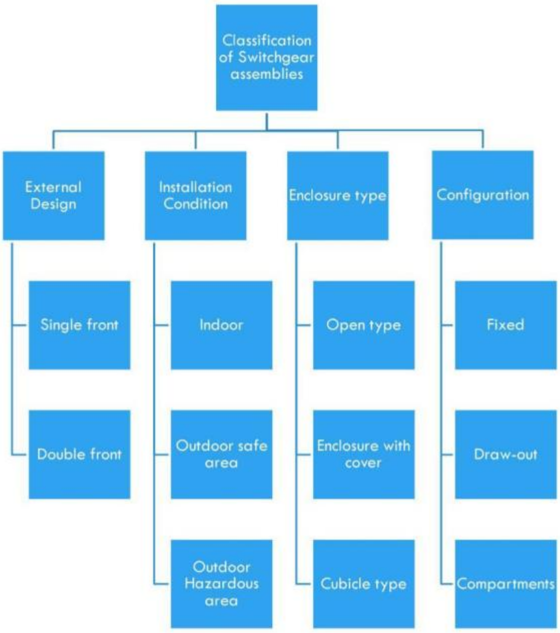
415V Diesel generator sets for standby / Emergency power supply

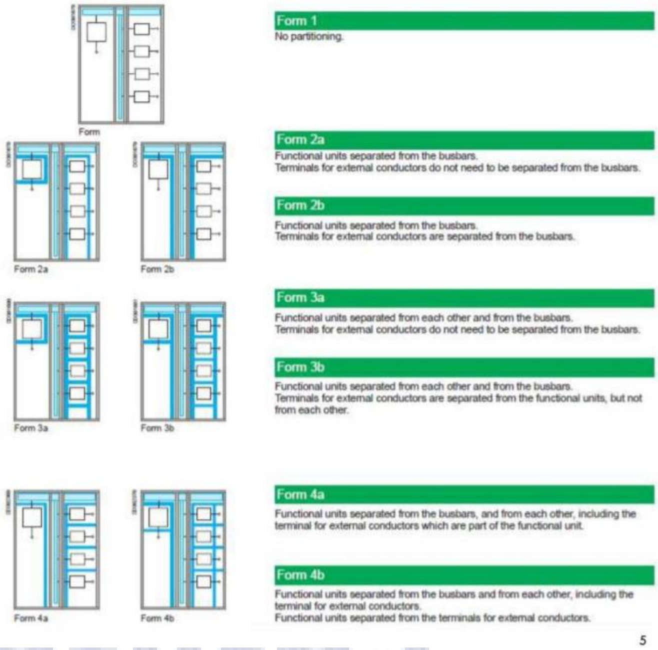
240V 1 ph diesel generator set for lighting and & small power only

12th May2021: Classification of Switchgear construction and power factor improvement

6	Classification of switchgear construction&power factor improvement	Different types of Switchgears assembles and construction features	Power factor improvement

Topic details: Classification of Switchgear constructions and Power Factor Improvement.





Switchgear includes switching & protecting devices like fuses, switches, CTs, VTs, relays, circuit breakers, etc. This device allows operating devices like electrical equipment, generators,distributors, transmission lines, etc.

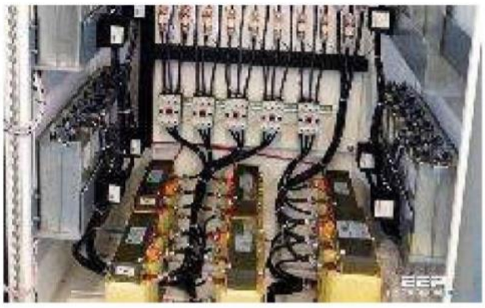
Power factor defined as the ratio of real power to volt-amperes and is the cosine of the phase angle between the voltage and current in an AC circuit.

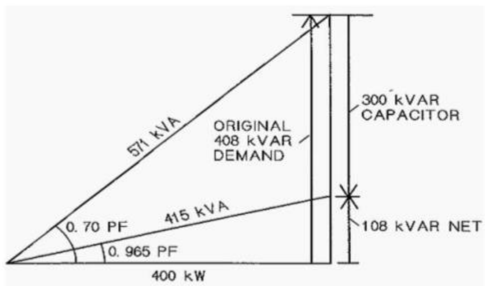
Power factor can be improved by adding capacitors on the power line to draw a leading current and supply lagging vars to the system. Capacitors can be switched in and out as necessary to maintain var and voltage control.

Many utilities charge industrial customers a certain rate for kilowatt-hours of energy consumed in a month, and another charge related to the infrastructure necessary to supply that power under the customer's conditions of operation.

If the customer is operating with a low power factor load, the demand charge is higher, because the current requirement is higher.

Power factor penalties on demand charges range from none to a factor of 2 on the peak power demand.





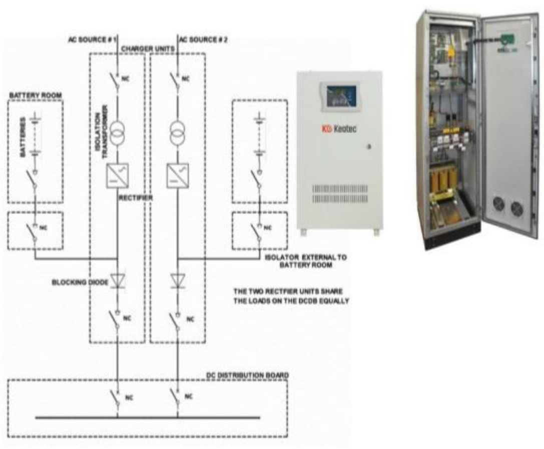
17th May2021: Detailing about UPS system and Busducts.

7	Detailing about UPS system andBus ducts	Uninterruptible power supply	AC and DC UPS systems
		Types and applications of Busducts	Segregated &non segregated phase busducts

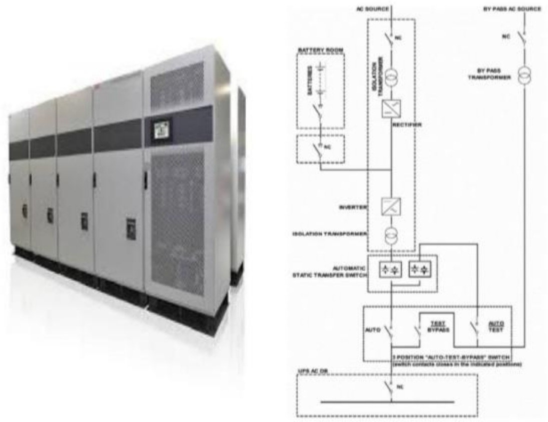
Topic details: Power distribution of UPS system and Busducts.

UPS SYSTEM:

A variety of design approaches are used to implement UPS systems, each with distinct performance characteristics. The most common design approaches are as follows:



110V or 220V DC
UPS System



110V or 230V
AC UPS System

Power disturbances occur in the electrical system environment and critical applications like plant control systems, computer-based operations, telecommunications or any other system critical for operations shall have uninterruptible power supply.

UPS systems are designed to provide continuous power to a load, even with an interruption or loss of utility supply power. UPS generally involves a balance of cost Vs need.

UPS systems shall be two types:

- AC UPS – 48V, 110V, 230V Single phase & 415V three phase

AC UPS power is required to feed power without any interruption to critical consumers in a facility during loss of normal power to critical plant loads like plant control systems, Emergency shut down systems. AC UPS derives its power from batteries. It also provides stabilized quality power even if it is from normal sources.

- DC UPS – 24V 48V, 110V, 220V

DC Uninterrupted Power Supply System (DC UPS) always available to the identified loads fed from a DC Distribution board that fed from the AC mains via a rectifier and when source supply outage charged batteries shall supply to the loads. These are required mainly for the Electrical Control & Protection system loads apart from a few other loads in certain plants like Switchgear closing/ Tripping operation on loss of power supply, critical DC lighting, DG starting.

Busducts:

Non-segregated busduct

Sandwich type busduct

A sheet metal duct with aluminium or copper bus bars as conductor, and used as a reliable link for transferring power from one equipment to other at desired voltage levels, used as an alternate means for conducting electricity to cable bus and power cables. Busducts are classified into various types depending on its application viz phase separated Busducts, segregated phase busducts, non-segregated phase busducts.

- Segregated Phase Busduct

These are metal enclosed busducts wherein all the three phase busbars are enclosed in a common enclosure and the all the phases are segregated by means of non-magnetic metal barriers preferably made of the same materials as that of the bus enclosure with degree of protection IP65.

The barriers are generally welded with the busduct enclosure simulating isolated compartments for each and every phase thus providing adequate shielding effect to the busbars under short circuit conditions due to the induced circulating currents in the enclosure whose phase angle is opposite in nature to that of busbars thus reducing the forces applied on the bus conductors.

- Non-segregated Phase Busduct

Non-segregated busduct, on the other hand, is almost similar to the above in construction wherein all the phase / neutral conductors are enclosed in a common enclosure with air as medium of insulation between phases. As the name implies, there is no metallic barriers between phases

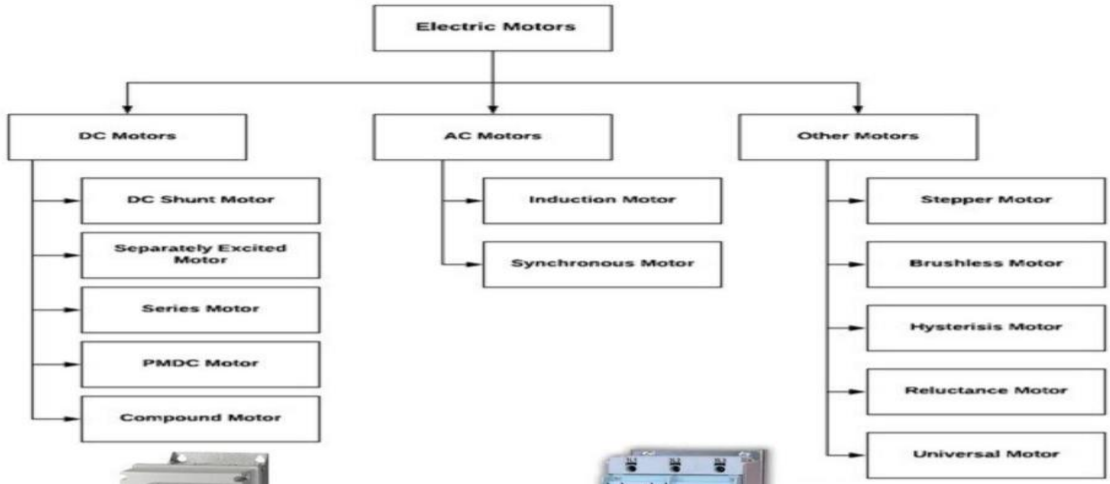
These busducts are relatively compact in comparison with segregated phase bus since the same are generally used for low voltage applications and thus needing much lower electrical clearances between phases and phase to earth.

These non-segregated phase busducts are offered in two variants-one with conventional design with R Y B N

18th May2021: Detailing about Motor Starters and Sizing of motors.

8	Detailing about Motor starters &Sizing of motors	Motor starters and drives	Sizing and selection of motors

Topic details: Detailing about Motor Starter and Sizing of motors and their selection



Soft starter to limit motors' starting current

Variable Speed Drive (VSD / VFD) for controlling speed based on requirement

The principal function of a motor starter is to start and stop the respective motor connected withspecially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is missing in a relay. Different types of motor starters are as follows:

1. Direct-On-Line Starter
2. Rotor Resistance Starter
3. Stator Resistance Starter
4. Auto Transformer Starter
5. Star Delta Starter

Motor Sizing

LV motors – based on driven equipment shaft power + 10-15% margin to select nearest standard size.

MV Motors - based on driven equipment shaft power + 5-10% margin and rounded off to nearest 10s.

Voltage: 0.18 to 160kW LV, 200 to 1800kW 3.3/6.6KV, >2000 11kV also depends on availability

Selection after sizing

Type - Synchronous or Induction motor

Environment – hazardous area, dusty, saliferous, altitude,

Application – Pump, Compressor, fan, Lift/Hoist/Crane etc.

Duty – based on application S1, S2, S3, S4, S5, S6

415V LV motors for industrial applications; Pumps, fans, agitators

Ingress protection – Dust & water, Enclosure – Explosion proof, industrial

Mounting – Horizontal, Vertical

Bearings – Single Ball, Double Ball, Roller, Sleeve.

Cooling – TEFC, TETV, TENV, TEWC

Temperature detectors – Winding (6 nos.) & Bearing (2 nos.)

Starting & running torque – Based application

19th May2021: Describing about Earthing system and Lighting Protection.

9	Describing about Earthing systemand Lighting Protection	Plant Earthing system	Lighting Protection materials

Topic details: Describing about Earthing system and Lighting Protection.

The purpose of earthing is to prevent damage to people and prevent or limit plant damage. Various earthing systems are provided with each earthing system is isolated from the other.

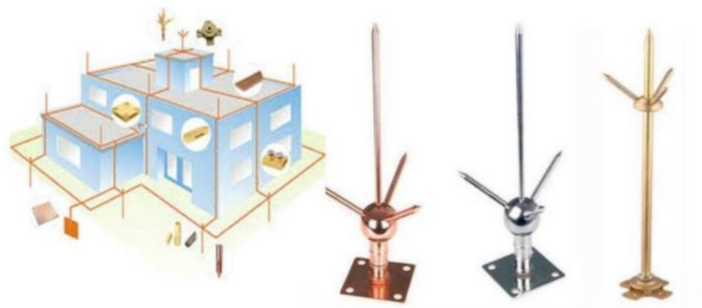
The purpose of earthing is to prevent damage to people and prevent or limit plant damage.

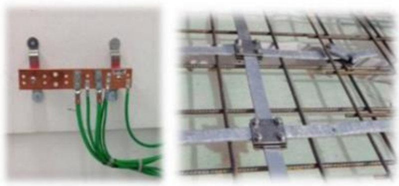
Various earthing systems are provided with each earthing system is isolated from the other.

System earthing (usually copper material), body earthing (also called dirty earth, usually GI/copper material), earthing for lightning protection (usually GI/copper material), Clean earth system for instrumentation (usually copper material) and Telecom earthing system (usually copper material). Earth pits are back-filled with earthing compound - Bentonite or Marconite. Bentonite is a moisture retaining clay used as an earth electrode back-fill to help lower soil resistivity. Marconite is a conductive compound mixed with cement. The Bentonite clay is a sodium activated montmorillonite which when mixed with water swells to many times its original volume.

Lightning protection required for high rise structures and important buildings against lightning currents during thunder storms. Primarily Lightning protection system calculationsare done based on soil resistivity, conductor material, coverage structure / Building to determine whether lightning protection is required or not.

Earthing material: earth bus, earth strip clamps test link etc.





Lightning protection air termination rods

Lightning protection earth strip and clamps

Earth pit chamber, earth bus, earth rods and accessories

20th May2021: Lighting or illumination systems and calculations.

10	Lighting/Illuminationsystems and Calculations	Lighting or illumination systems	Lighting calculations

Topic details: Lighting or Illumination systems and Calculations.

All outdoor lighting fittings shall be connected with armoured PVC cable of suitable no.of cores and size. Necessary type and no. of junction boxes shall be provided for branch connections. Indoor light fittings shall be connected with FRLS PVC wires laid in cable trunks or conduits.

Pole mounted LED lighting fixtures for platforms

Well glass flame proof type outdoor light fitting for Oil & Gas industry

High bay LED lighting fitting used in workshops compressor stations

240V LED light fittings for indoor industrial

Junction box for connecting looping light fittings

415V 3Ph 63A outdoor Welding Socket maintenance work

10

- Inputs required: Equipment and cable routing layouts, lighting calculations, Design basisfor type of light fittings to be used, required lux levels.
- Lighting calculations software: Dialux, Chalmlite, Calculux, Relux, Luxicon, CG Lux.
- Applicable Standards: IS 6665: Code of practice for industrial lighting, IS 3646: Code of practice for Interior illumination, IEC 60598: Luminaires, IEC 62493: Assessment of lighting equipment related to human exposure to electromagnetic field.
- Deliverables: Indoor Lighting layouts, socket outlet layouts, Street lighting and arealighting layouts. BOQ.
- Types of light fittings: Industrial, flame proof type (EX d), increased safety type (Ex e).
- Lighting fittings shall be of energy efficient type.
- LED/HPMV lamps shall be generally used for outdoor plant lighting. HPSV lamps shall be used for street lighting and area lighting. Now a days most of the outdoor lighting are designed LED type lamps.
- LED / Fluorescent lamps shall be used for indoor lighting for non-process building and control room. All chemical handling facilities shall be provided with chemical resistant fixtures.

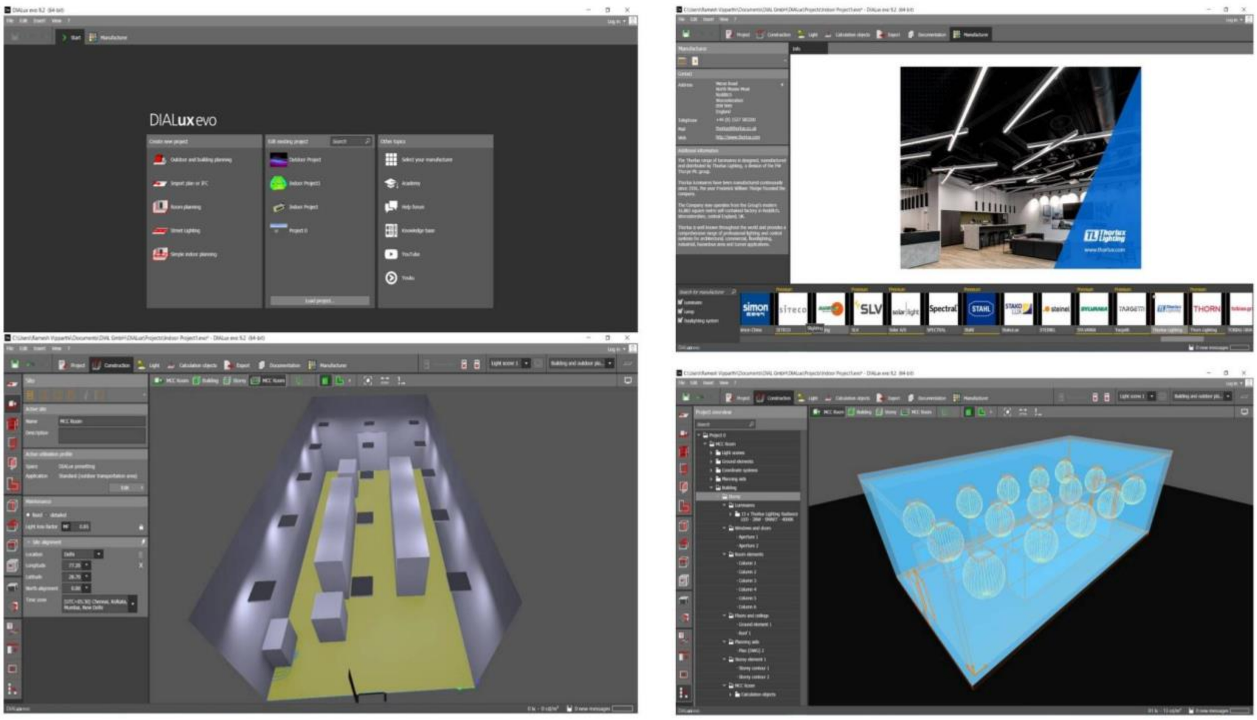
21th May2021: Lighting or illumination systems using DIALUX software.

11	Lighting or Illumination usingDIALUX software	Lighting or illumination systems	Operation of dialux software

Topic details: Lighting or Illumination Calculations using DIALUX software.

Here we are using Dialux evo 5.9.2 software windows to construct the powerplant and by using this software we can perform lighting or illumination calculations, indoor and outdoor calculations.

Dialux evo 5.9.2 software windows



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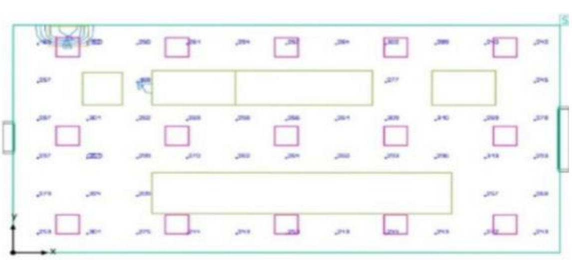
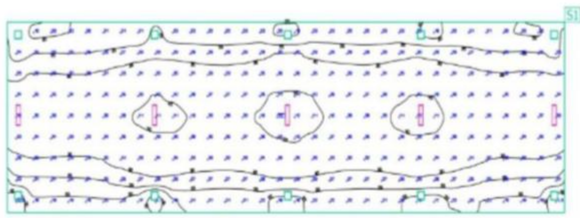
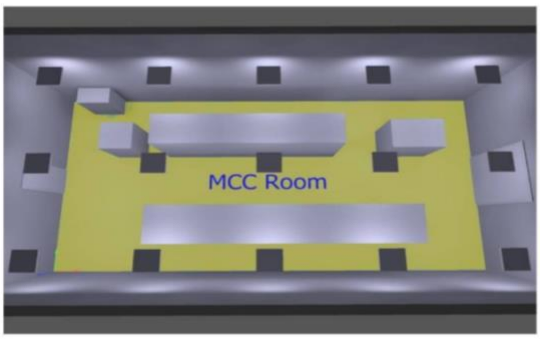
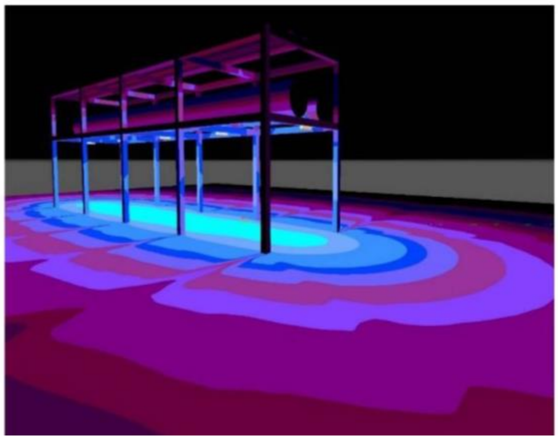
Indoor and outdoor results:







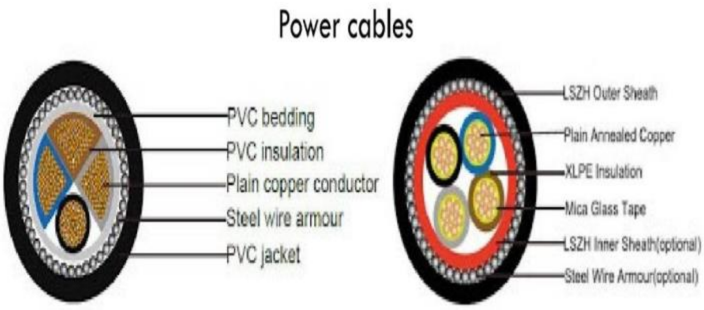


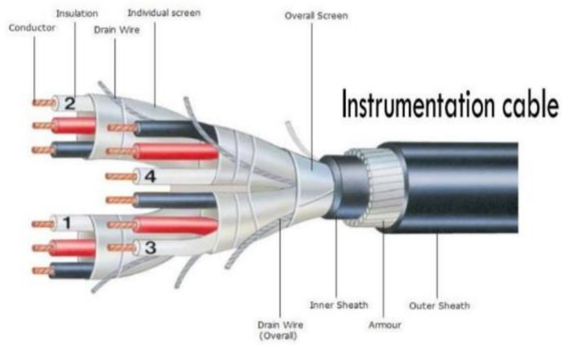
24th May2021: Cabling and their calculations and types.

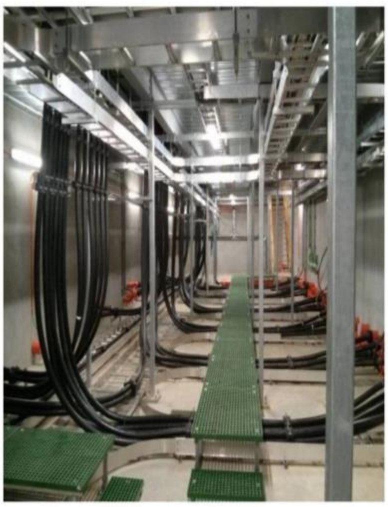
12	Cabling and their types and calculations	Cabling calculations & Cable specifications	Types of cabling materials

Topic details: Cabling and their types and calculations.

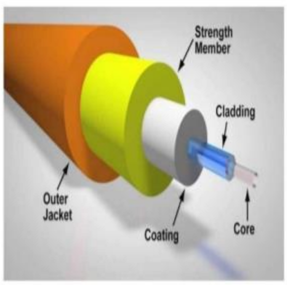
- Electrical cables must be properly supported to relieve mechanical stresses on the conductors, and protected from harsh conditions such as abrasion which might degrade theinsulation.
- Cables generally laid in the cable trays above ground, direct buried underground and inmetallic or PVC conduits. Derating factors may be applicable for each type of cable laying conditions.
- Cable trays shall be generally loaded 60 to 70% leaving space for future use.
- Underground cabling shall be done in concrete cable trenches with cable trays in pavedareas and directly buried with mandatory gap of 300mm between different systems of cables.



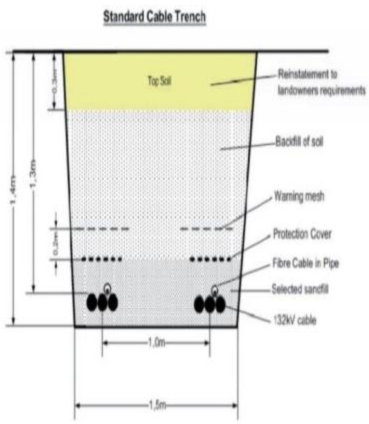




Substation cable cellar cable trays



Fibre Optic cable



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25th May2021: Cabling calculations and Cable gland selection.

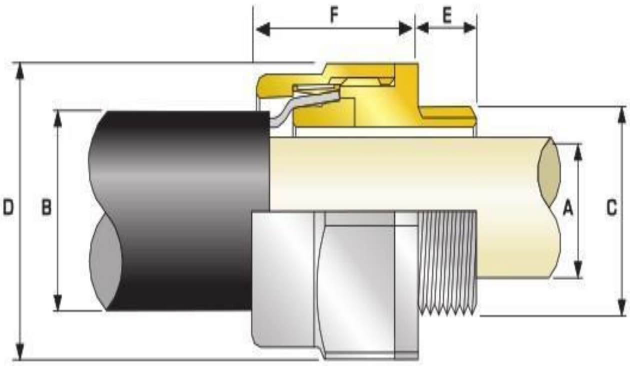
13	Cabling calculations and cable gland selection	Cabling sizing calculations	Cable gland selection

Topic details: Cable sizing calculation and cable gland selection.

Inputs required: Load List, Design basis, Electrical equipment layout, cable schedule, vendorcatalogues for cable tray. Cable tray sizing shall be performed for each branch of cable tray routing up to the load point. Results shall be checked with specified limits mentioned in design basis.

Cable gland:

Cable glands are mechanical cable entry devices and can be constructed from metallic or non-metallic materials. Cable glands are used on all types of electrical power, control, instrumentation, data and telecommunications cables. They are used as a sealing and termination device to ensure that the characteristics of the enclosure which the cable enters can be maintained adequately.



Cable glands are made from Plastic, Brass Nickle plated, Aluminium & Stainless steel and they are Single compression type & Double compression type.

Important specifications for cable glands:

- The hole diameter is the maximum diameter of a cable.
- The cable diameter specifies the diameter of the cable that can be through the cable gland.
- The mounting hole diameter refers to the diameter of the barrier on which the gland is to be installed.

Cable Gland Selection Table
Refer to illustration at the top of the page.

Cable Gland Size	Available Entry Threads "C" (Alternate Metric Thread Lengths Available)		Cable Bedding Diameter "A"	Overall Cable Diameter "B"	Armour Range		Across Flats "D"	Across Corners "D"	Protrusion Length "F"
	Metric	Thread Length (Metric) "E"	Max	Max	Min	Max	Max	Max	
20S16	M20	10.0	8.7	13.2	0.8	1.25	24.0	26.4	35.2
20S	M20	10.0	11.7	15.9	0.8	1.25	24.0	26.4	32.2
20	M20	10.0	14.0	20.9	0.8	1.25	30.5	33.6	30.6
25	M25	10.0	20.0	26.2	1.25	1.6	36.0	39.6	36.4
32	M32	10.0	26.3	33.9	1.6	2.0	46.0	50.6	32.6
40	M40	15.0	32.2	40.4	1.6	2.0	55.0	60.5	36.6
50S	M50	15.0	38.2	46.7	2.0	2.5	60.0	66.0	39.6
50	M50	15.0	44.1	53.1	2.0	2.5	70.1	77.1	39.1
63S	M63	15.0	50.0	59.4	2.0	2.5	75.0	82.5	52.0
63	M63	15.0	56.0	65.9	2.0	2.5	80.0	88.0	49.8
75S	M75	15.0	62.0	72.1	2.0	2.5	90.0	99.0	63.7
75	M75	15.0	68.0	78.5	2.5	3.0	100.0	110.0	57.3
90	M90	24.0	80.0	90.4	3.15	4.0	114.3	125.7	66.6

28th May 2021: Load calculations and Transformer sizing calculations

14	Load calculations and TR calculations	Load calculations	TR calculations

Sl. No.	Equipment No.	Equipment Description	Breaker Rating (A)	Breaker Type	Breaker No. of Poles	ELCB Rating (mA)	Absorbed Load [A] kW	Motor / Load Rating [B] kW	Load Factor [A] / [B] [C] decimal	Efficiency at Load Factor [C] [D] decimal	Power Factor at Load Factor [C] cos φ	Continuous kW (kW = [A] / [D])	Continuous kVAR	Intermittent kW (Consumed Load)	Intermittent kVAR	Stand-by kW (kVAR = kW x tan φ)	Stand-by kVAR
1	PU2315	Silica filter feed pump					18.96	22.00	0.86	0.91	0.78	20.84	16.72				
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					5.50	7.50	0.73	0.85	0.73	6.5	6.1				
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					4.74	7.50	0.63	0.85	0.73					5.6	5.2
4	PU2305	Feed Pump (Seperator)					19.14	7.50	2.55	0.91	0.78	21.0	16.9				
5	MX2305	MIXER (W)					19.29	7.50	2.57	0.91	0.78	21.2	17.0				
6	MX 2308	MIXER (S)					19.29	7.50	2.57	0.91	0.78					21.2	17.0
7	BW2313	Blower					8.29	7.50	1.11	0.85	0.73	9.8	9.1				
8	Rotary valve	TK 2313B (I)					0.81	7.50	0.11	0.85	0.73			1.0	0.9		
9	SC2314	Screw conveyor (I)					1.86	7.50	0.25	0.85	0.73			2.19	2.05		
10	AG 2324A	Citric acid tan agitator (W)					1.39	7.50	0.19	0.85	0.73	1.64	1.53				
11	AG 2324B	Citric acid tank agitator (S)					1.39	7.50	0.19	0.85	0.73					1.6	1.5
12	AG 2305	Citric oil rection vessol agitator					5.08	7.50	0.68	0.85	0.73	5.98	5.60				
13	AG 2309	Lye oil reaction vessel agitator					1.84	7.50	0.25	0.85	0.73	2.16	2.03				
14	AG 2310	Lye oil reaction vessel agitator					1.84	7.50	0.25	0.85	0.73	2.16	2.03				
15	AG 2314	Soap Adsorbant Tank Agitator					3.23	7.50	0.43	0.85	0.73	3.80	3.56				
	Maximum of normal running plant lo (Est. x%E + y%F)	96.0		81.4 kVAR			sqrt (kW² +kVAR²) =	125.8	kVA		TOTAL	95.03	80.52	3.14	2.94	28.41	23.76
	Peak Load : (Est. x%E + y%F + z%G)	98.8		83.8 kVAR			sqrt (kW² +kVAR²) =	129.6	kVA		kVA	124.56		4.30		37.03	

Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <= 45	0.91	0.78
> 45 - < 150	0.93	0.82
>= 150	0.94	0.91

Calculation for Transformer Capacity

1.0 Example of calculation for Transformer Capacity

1.1 Calculation for consumed load

Consumed loads used for this example are as follows :

		kW	kVar	kVA	
a.	Continuous load	95.03	80.5	124.56	--- (i)
b.	Intermittent load / Diversity Factor	3.14	2.9	4.30	--- (ii)
c.	Stand-by load required as consumed load	28.41	23.8	37.04	--- (iii)
	Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	98.8	83.8	129.55	
	Future expansion load (20% capacity)	19.8	16.8	25.91	
	Total Load =	118.6	100.5	155.46	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	129.5 kVA
Spare capacity	=	25.9 kVA
Required capacity	=	155.5 kVA
Transformer rated capacity	=	160 kVA

1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW), while all the other loads running , the voltage regulation is as follows :

P_T = 160 KVA (%Z)= 4 & Ratio X/R = 1.5

Hence , %R = $\frac{8}{\sqrt{(1+(17)^2)}}$ = 2.219 %

%X = 0.47 x 17 = 3.33 %

P_M = 22 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.η = 0.91 & Cos θs = 0.25

P_S = 6 x 1 x $\frac{3400}{0.90 \times 0.93}$ = 185.97 KVA

Cos θ_s = 0.25 ,Corresponding to Angle θ_s = 75.522 Degrees for which Sin θ_s = 0.97

P_p = 96.42 KVA & PB in KW is = 81.957 & P_p in Kvar = 50.81 ∴ Cos θ_p = 0.850

Cos θ_p = 0.85 ,Corresponding to Angle θ_p = 31.788 Degrees, for which Sin θ_p = 0.53

P_{cp} = = 128.45 KW

P_{cq} = = 230.87 KVAR

P_c = = 264.2 KVA

Cos θ_c = = 0.4862 , where as Sin θ_c = 0.874

Voltage Regulation ε = ———————— = 6.6 %

Result During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx. 6.4% , which meets the criteria to maintain less than 15% voltage regulation.

1.4 Selection of rated capacity

120 kVA transformer selected.

29th May2021: DG set calculations

15	DG set calculations

Topic details: Transformer and DG set calculations, types, sizing or selections

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.743	Avg
	Efficiency	0.866	Avg
	Total operating load on DG set in kVA at 0.743 power factor	**125.8**	
	Largest motor to start in the sequence - load in KW	22	KW
	Running kVA of last motor (CosØ= 0.91)	34	KVA
	Starting current ratio of motor	6	method as Soft starter)
	Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	**205**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**92**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**92**	**KVA**
B	**Transient Voltage dip during starting of Last motor P2**		
	Total momentary load in KVA	297	KVA
	(Starting KVA of the last motor+Base load of DG set in KVA		
	Subtransient Reactance of Generator (Xd'')	7.91%	(Assumed)
	Transient Reactance of Generator (Xd')	10.065%	(Assumed)
	Xd''' =(Xd"+Xd')/2	0.089875	
	Transient Voltage Dip	15%	(Max)
	Transient Voltage dip during Soft starter starting of Last motor (Transient Voltage	**151**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	297	KVA
	overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
	Capacity of DG set required considering overload capacity (P3) = $\frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$	**198**	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	92	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	151	KVA
	Overload capacity P3	198	KVA
	Considering the last value amongst P1, P2 and P3	**198**	**KVA**

Hence, Existing Generator 198 KVA is adequate to cater the loads as per re-scheduled loads

NOTE:VOLTAGE DIP CONSIDERED - 15%

2nd june2021: Calculations of Earthing and Lighting protection.

16	Calculation of Earthing and Lighting protectioncalculations	Earthing calculations	Lighting protection calculation

Topic details: Calculation of Earthing and Lighting protection calculations

EARTHING CALCULATIONS INPUTS		
	2	
Maximum line-to-ground fault in kA for 1 sec	17	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.5	
Average depth / length of Earth rod in meters	4.5	
Soil resistivity Ω-meter	9	
Ambient temperature in deg C	55	
Plot dimensions (earth grid) L x B in meters	80	140
Number of earth rods in nos.	2	
Earth electrode sizing:		
Ac - Required conductor cross section in sq.mm		

$$I_{lg} = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_0 + T_m}{K_0 + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032	
pr - Resistivity of ground conductor at 20 oC	20.10	
Ta - Ambient Temperature is °C	50	
I_{l-g} - RMS fault current in kA = 50 KA	17	
tc - Short circuit current duration sec	1	
Thermal capacity factor, TCAP J/(cm3.oC)	3.93	
Tm - Maximum allowable temperature for copper conductor, in oC	419	
K0 - Factor at oC	293	
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:		
17 = Ac *	0.123	
Ac - Required conductor cross section in sq.mm	138	
Earth rod dia in mm	13	
Earth rod dia (including 25% corrosion allowance) in mm	17	

Table 1—Material constants

Description	Material conductivity (%)	α_r factor at 20 °C (1/°C)	K_o at 0 °C (0 °C)	Fusing[a] temperature T_m (°C)	ρ_r 20 °C (μΩ-cm)	TCAP thermal capacity [J/(cm³·°C)]
Copper, annealed soft-drawn	100.0	0.003 93	234	1083	1.72	3.42
Copper, commercial hard-drawn	97.0	0.003 81	242	1084	1.78	3.42
Copper-clad steel wire	40.0	0.003 78	245	1084	4.40	3.85
Copper-clad steel wire	30.0	0.003 78	245	1084	5.86	3.85
Copper-clad steel rod[b]	20.0	0.003 78	245	1084	8.62	3.85
Aluminum, EC grade	61.0	0.004 03	228	657	2.86	2.56
Aluminum, 5005 alloy	53.5	0.003 53	263	652	3.22	2.60
Aluminum, 6201 alloy	52.5	0.003 47	268	654	3.28	2.60
Aluminum-clad steel wire	20.3	0.003 60	258	657	8.48	3.58
Steel, 1020	10.8	0.001 60	605	1510	15.90	3.28
Stainless-clad steel rod[c]	9.8	0.001 60	605	1400	17.50	4.44
Zinc-coated steel rod	8.6	0.003 20	293	419	20.10	3.93
Stainless steel, 304	2.4	0.001 30	749	1400	72.00	4.03

[a]From ASTM standards.
[b]Copper-clad steel rods based on 0.254 mm (0.010 in) copper thickness.
[c]Stainless-clad steel rod based on 0.508 mm (0.020 in) No. 304 stainless steel thickness over No. 1020 steel core.

The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:

14 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	114
Earth flat area in mm	12
Earth flat area (including 25% corrosion allowance) in mm	15
Selected flat size W * Thk in sq mm	20

Rg - Grid resistance
Grid resistance can be calculated using Eq. 52 of IEEE 80

$$R_g = \rho \left\{ \frac{1}{L} + \frac{1}{\sqrt{20 \times A}} \left[1 + \frac{1}{1 + h\sqrt{20/A}} \right] \right\}$$

ρ - Soil resistivity in Ω-meter=	9
L - Total buried length of ground conductor in meter	440
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	11200
Rg - Grid resistance	0.058

Rr - Earth Electrode resistance
Grid resistance can be calculated using Eq. 55 of IEEE 80

$$R_r = \frac{\rho}{2 \times \pi \times n_r \times L_r} \left\{ l_n \left[\frac{4 \times L_r}{b} \right] - 1 + \frac{2 \times k_1 \times L_r}{\sqrt{A}} \left(\sqrt{n_r} - 1 \right)^2 \right\}$$

ρ - Soil resistivity in Ω-meter, 16.96	9
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	4.5
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	11200
Rr - Earth Electrode resistance	3.30673

Grounding system resistance
Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:

$$R_s = \frac{R_g \times R_2 - R_m^2}{R_g + R_2 - 2R_m}$$

R_m - Mutual ground resistance between the group of ground conductors, R_g and group of electrodes, R_r in Ω. Neglected R_m, since this is for homogenous soil

Rs - Total earthing system resistance 0.057

The calculated resistance grounding system is less than the allowable 1 Ω value.

5th June 2021: Cable sizing and cable tray sizing calculations.

17	Cable sizing and cable tray sizing calculations	Cable sizing calculations	Cable tray calculation

Topic details: Cable sizing and cable tray sizing calculations for LV cables and MV/HV cables.

Cable sizing:

Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Starting Current (A)	Load P.F. Running	SIN φ Running	Motor P.F Staring	SIN φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)
[illegible]	12.47	15.00	415	3	21.7	130.12	0.8	0.6	0.8	0.5	2	1	4.0	10	66
[illegible]	3.62	4.70	415	3	6.3	37.77	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28
[illegible]	3.11	3.70	415	3	5.4	32.45	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28
[illegible]	12.59	15.00	415	3	21.9	131.26	0.8	0.6	0.8	0.5	2	1	4.0	6	51
MIXER (1)	12.61	15.00	415	3	22.1	132.31	0.8	0.6	0.8	0.5	2	1	4.0	6	51
MIXER (2)	12.61	15.00	415	3	22.1	132.31	0.8	0.6	0.8	0.5	2	1	4.0	10	66
[illegible]	5.45	7.50	415	3	9.5	56.87	0.8	0.6	0.8	0.5	2	1	4.0	6	51
[illegible]	0.53	0.75	415	3	0.9	5.53	0.8	0.6	0.8	0.5	2	1	4.0	6	51
[illegible]	1.23	1.50	415	3	2.1	12.83	0.8	0.6	0.8	0.5	2	1	4.0	6	51
[illegible]	0.91	1.10	415	3	1.6	9.50	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28
[illegible]	0.91	1.10	415	3	1.6	9.50	0.8	0.6	0.8	0.5	2	1	4.0	6	51
[illegible]	3.34	3.70	415	3	5.8	34.85	0.8	0.6	0.8	0.5	2	1	4.0	6	51
[illegible]	1.21	1.50	415	3	2.1	12.63	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28
[illegible]	1.21	1.50	415	3	2.1	12.63	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28
[illegible]	2.12	3.00	415	3	3.7	22.12	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28

Description	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result
[illegible]	0.98	0.9	1	1	0.882	58.2	95	2.3400	0.0852	6.86	1.65	40.99	9.88	OK
[illegible]	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	7.92	1.91	47.45	11.43	OK
[illegible]	0.98	0.9	1	1	0.882	24.7	60	9.4800	0.1007	4.30	1.04	25.75	6.20	OK
[illegible]	0.98	0.9	1	1	0.882	45.0	85	3.9400	0.0902	10.33	2.49	61.78	14.89	OK
MIXER (1)	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	9.18	2.21	54.95	13.24	OK
MIXER (2)	0.98	0.9	1	1	0.882	58.2	105	2.3400	0.0852	7.71	1.86	46.07	11.10	OK
[illegible]	0.98	0.9	1	1	0.882	45.0	100	3.9400	0.0902	5.26	1.27	31.49	7.59	OK
[illegible]	0.98	0.9	1	1	0.882	45.0	100	3.9400	0.0902	0.51	0.12	3.06	0.74	OK
[illegible]	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	0.89	0.21	5.33	1.28	OK
[illegible]	0.98	0.9	1	1	0.882	24.7	110	9.4800	0.1007	2.30	0.56	13.81	3.33	OK
[illegible]	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	0.66	0.16	3.94	0.95	OK
[illegible]	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	3.39	0.82	20.26	4.88	OK
[illegible]	0.98	0.9	1	1	0.882	24.7	85	9.4800	0.1007	2.37	0.57	14.19	3.42	OK
[illegible]	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	2.65	0.64	15.86	3.82	OK
[illegible]	0.98	0.9	1	1	0.882	24.7	65	9.4800	0.1007	3.17	0.76	19.01	4.58	OK

Cable tray sizing:

Sr. No.	Cable Route (From-To)	Type & Cable Size	Size of Cable (mm2)	No. of Cable	Overall Diameter of each Cable (mm)	Sum of Cable OD (mm)	Self Weight of Cable (Kg/Mt)	Total Weight of Cable (Kg/Mt)	Remarks
1	LV MCC	4	10	1	18	18	3.95	0.9	
2	PU2315- VFD	4	10	1	18	18	0.37	0.9	
3	PU2315- VFD	5	1.5	1	15	15	3.95	0.4	
4	LV MCC	4	2.5	1	16	16	0.37	0.5	
5	LV MCC	5	1.5	1	15	15	3.95	0.4	
6	LV MCC	4	2.5	1	16	16	0.37	0.5	
7	PU 2314 -B- VFD	4	2.5	1	16	16	0.9	0.5	
8	PU 2314 -B- VFD	5	1.5	1	15	15	0.9	0.4	
9	LV MCC	4	6	1	18	18	2.9	0.7	
10	PU2305- VFD	4	6	1	18	18	1.2	0.7	
11	PU2305- VFD	5	1.5	1	15	15	1.2	0.4	
12	LV MCC	4	6	1	18	18	1.2	0.7	
13	LV MCC	5	1.5	1	15	15	1.45	0.4	
14	LV MCC	4	10	1	18	18	2	0.9	
15	LV MCC	5	1.5	1	15	15	2.4	0.4	
16	LV MCC	4	6	1	18	18	2.4	0.7	
17	BW2313- VFD	4	6	1	18	18	0.85	0.7	
18	BW2313- VFD	5	1.5	1	15	15	0.85	0.4	
19	LV MCC	4	6	1	18	18	0.85	0.7	
20	LV MCC	5	1.5	1	15	15	1	0.4	
21	LV MCC	4	6	1	18	18	0.85	0.7	
	Total			21		348	33.91	12.3	

Calculation			Result		
Maximum Cable Diameter:	18	mm	Selected Cable Tray width:	O.K	
Consider Spare Capacity of Cable Tray:	30%		Selected Cable Tray Depth:	O.K	
Distance between each Cable:	0	mm	Selectrd Cable Tray Weight:	O.K	Including Spare Capacity
Calculated Width of Cable Tray:	452	mm	Selected Cable Tray Size:	O.K	Including Spare Capacity
Calculated Area of Cable Tray:	8143	Sq.mm			
No of Layer of Cables in Cable Tray:	2		Required Cable Tray Size:	300 x 50	mm
Selected No of Cable Tray:	1	Nos.	Required Nos of Cable Tray:	1	No
Selected Cable Tray Width:	300	mm	Required Cable Tray Weight:	150.00	Kg/Meter/Tray
Selected Cable Tray Depth:	50	mm	Type of Cable Tray:	Ladder	
Selected Cable Tray Weight Capacity:	150	Kg/Meter			
Type of Cable Tray:	Ladder		Cable Tray Width Area Reman	25%	
Total Area of Cable Tray:	15000	Sq.mm	Cable Tray Area Remaning:	46%	

Conclusion:

We have been taught many aspects of engineering activities during the EPC stages for all electrical and industrial related and other disciplines also.

Feedback:

Smart Bridge

They conducted summer internships, workshops, debates, hackthons, and technical sessions.

Method of conducting program

Online virtual sessions with the help of presentation slides clear explanation on the topic and practical usage of the topic and with some examples.

Program highlights

It is for the detailed design of any industrial sectors.

ASSIGNMENT 1
ELECTRICAL LOAD CALCULATIONS LV MCC

Sl. No.	Equipment No.	Equipment Description	Breaker Rating	Breaker Type	Breaker No. of Poles	ELCB Rating	Absorbed Load [A]	Motor / Load Rating [B]	Load Factor [A] / [B] [C]	Efficiency at Load Factor [C] [D]	Power Factor at Load Factor [C]	Consumed Load (kW = [A] / [D], kVAR = kW x tan φ) Continuous		Intermittent		Stand-by		Remarks
			A			mA	kW	kW	decimal	decimal	cos φ	kW	kVAR	kW	kVAR	kW	kVAR	
1	PU2315	Silica filter feed pump					18.96	22.00	0.86	0.91	0.78	20.84	16.72					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					5.50	7.50	0.73	0.85	0.73	6.5	6.1					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					4.74	5.50	0.86	0.85	0.73					5.6	5.2	
4	PU2305	Feed Pump (Seperator)					19.14	22.00	0.87	0.91	0.78	21.0	16.9					
5	MX2305	MIXER (W)					19.29	22.00	0.88	0.91	0.78	21.2	17.0					
6	MX 2308	MIXER (S)					19.29	22.00	0.88	0.91	0.78					21.2	17.0	
7	BW2313	Blower					8.29	9.20	0.90	0.85	0.73	9.8	9.1					
8	Rotary valve	TK 2313B (I)					0.81	1.10	0.74	0.85	0.73			1.0	0.9			
9	SC2314	Screw conveyor (I)					1.86	2.20	0.85	0.85	0.73			2.19	2.05			
10	AG 2324A	Citric acid tan agitator (W)					1.39	1.50	0.93	0.85	0.73	1.64	1.53					
11	AG 2324B	Citric acid tank agitator (S)					1.39	1.50	0.93	0.85	0.73					1.6	1.5	
12	AG 2305	Citric oil rection vessol agitator					5.08	5.50	0.92	0.85	0.73	5.98	5.60					
13	AG 2309	Lye oil reaction vessel agitator					1.84	2.20	0.84	0.85	0.73	2.16	2.03					
14	AG 2310	Lye oil reaction vessel agitator					1.84	2.20	0.84	0.85	0.73	2.16	2.03					
15	AG 2314	Soap Adsorbant Tank Agitator					3.23	3.70	0.87	0.85	0.73	3.80	3.56					
		TOTAL										95.03	80.52	3.14	2.94	28.41	23.76	
		kVA										124.56		4.30		37.03		

Maximum of normal running plant load : 96.0 kW 81.4 kVAR sqrt (kW² +kVAR²) = 125.8 kVA
(Est. x%E + y%F)

Peak Load : 98.8 kW 83.8 kVAR sqrt (kW² +kVAR²) = 129.6 kVA
(Est. x%E + y%F + z%G)

Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <= 45	0.91	0.78
> 45 - < 150	0.93	0.82
>= 150	0.94	0.91

2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for contnious, intermittent and standby load.

ASSIGNMENT 2
Calculation for Transformer Capacity

1.0 Example of calculation for Transformer Capacity
1.1 Calculation for consumed load
Consumed loads used for this example are as follows :

	kW	kVar	kVA	
a. Continuous load	95.03	80.5	124.56	--- (i)
b. Intermittent load / Diversity Factor	3.14	2.9	4.30	--- (ii)
c. Stand-by load required as consumed load	28.41	23.8	37.04	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	98.8	83.8	129.55	
Future expansion load (20% capacity)	19.8	16.8	25.91	
Total Load =	118.6	100.5	155.46	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load = 129.5 kVA
Spare capacity = 25.9 kVA
Required capacity = 155.5 kVA
Transformer rated capacity = 160 kVA

1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW) , while all the other loads running , the voltage regulation is as follows :

P_T = 160 KVA (%Z)= 4 & Ratio X/R = 1.5

Hence , **%R** = $\frac{8}{\sqrt{(1 + (17)^2)}}$ = 2.219 %

%X = 0.47 x 17 = 3.33 %

P_M = 22 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.η = 0.91 & Cos Θs = 0.25
P_S = 6 x 1 x $\frac{3400}{0.90 \times 0.93}$ = 185.968 KVA

Cos θ_S = 0.25 ,Corresponding to Angle θ_s = 75.5225 Degrees for which Sin θ_s = 0.97
P_B = 96.42 KVA & PB in KW is = 81.957 & P_B in Kvar = 50.81 ∴ Cos θ_B = 0.850
Cos θ_B = 0.85 ,Corresponding to Angle θ_s = 31.7883 Degrees, for which Sin θ_s = 0.53

P_{CP} = = 128.449 KW
P_{CQ} = = 230.873 KVAR
P_C = = 264.199 KVA
Cos θ_C = = 0.48618 , where as Sin θ_C = 0.874

Voltage Regulation ε = ———————— = 6.6 %

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx. 6.4% , which meets the criteria to maintain less than 15% voltage regulation.

1.4 Selection of rated capacity
120 kVA transformer selected.

ASSIGNMENT-3

DG SIZING CALCULATIONS

	Rated Volatge	415	KV
	Power factor (CosØ)	0.743	Avg
	Efficiency	0.866	Avg
	Total operating load on DG set in kVA at 0.743 power factor	**125.8**	
	Largest motor to start in the sequence - load in KW	22	KW
	Running kVA of last motor (CosØ= 0.91)	34	KVA
	Starting current ratio of motor	6	(Considering starting method as Soft starter)
	Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	**205**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**92**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**92**	**KVA**
B	**Transient Voltage dip during starting of Last motor P2**		
	Total momentary load in KVA	297	KVA
	(Starting KVA of the last motor+Base load of DG set in KVA		
	Subtransient Reactance of Generator (Xd’’)	7.91%	(Assumed)
	Transient Reactance of Generator (Xd’)	10.065%	(Assumed)
	Xd’’’ =(Xd"+Xd')/2	0.089875	
	Transient Voltage Dip	15%	(Max)
	Transient Voltage dip during Soft starter starting of Last motor P2 = Total momentary load in KVA x Xd'" x <u>(1-Transient Voltage Dip)</u> (Transient Voltage Dip)	**151**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	297	KVA
	overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
	Capacity of DG set required considering overload capacity (P3) = <u>Total momentary load in KVA</u> overcurrent capacity of DG (K)	**198**	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	92	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	151	KVA
	Overload capacity P3	198	KVA
	Considering the last value amongst P1, P2 and P3	**198**	**KVA**

Hence, Existing Generator 198 KVA is adequate to cater the loads as per re-scheduled loads

NOTE:VOLTAGE DIP CONSIDERED - 15%

ASSIGNMENT-4

LIGHTENING CALCULATIONS

1

Location	Karnool
Building	Concrete, Industrial
Type of Building	Flat Roofs (a)
Building Length (L)	15
Building breadth (W)	5
Building Height (H)	6

Risk Factor Calculation

1 **Collection Area (A_c)**

A_c = (L*W) + (2*L*H) + (2*W*H)

428.04

2 **Probability of Being Struck (P)**

P = $A_c * N_g * 10^{-6}$

0.000813276

3 **Overall weighing factor**

a) Use of structure (A)		=	1.0
b) Type of construction (B)		=	0.8
c) Contents or consequential effects (C)		=	0.3
d) Degree of isolation (D)		=	1.0
e) Type of country (E)		=	0.3
Wo - Overall weighing factor		=	A * B * C * D * E
		=	0.072
4 **Overall Risk Factor**	Po	=	P * Wo
	Po	=	5.85559E-05
	Pa		10^{-5}

As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor (Po) has been taken as 10^{-5}

Since Po > Pa lightning protection required.

5 **Air Terminations**

Perimeter of the building	=	2(L+W)	
	=	40	Mts.

6 **Down Conductors**

Perimeter of building	=	40	Mts.
No. of down conductors based on perimeter	=	2	Nos.

Hence 2 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Galvanized Ste

(As per BS6651, lightning currents have very short duration, therefore thermal factors are of little consequence in deciding the cross-section of the conductor. The minimum size of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)

ASSIGNMENT-5

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Motor Starting Current (A)	Load P.F. Running	SIN Φ Running	Motor P.F Staring	SIN Φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
3	LV MCC	PU2315	Silica filter feed pump	10.80	15	415	3	18.8	112.69	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	95	3.9400	0.0902	9.91	2.39	59.28	14.28	OK	18	20
4	LV MCC	PU2322A	Soft water pump	3.15	3.7	415	3	5.5	32.82	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	6.88	1.66	41.22	9.93	OK	16	20s
5	LV MCC	PU 2314A	Absorbesnt/Neutral oil pump	1.87	2.2	415	3	3.3	19.51	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	60	9.4800	0.1007	2.58	0.62	15.48	3.73	OK	16	20s
6	LV MCC	PU2324	Citric Acid Tank pump	1.28	1.5	415	3	2.2	13.30	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	85	9.4800	0.1007	2.50	0.60	14.95	3.60	OK	16	20s
7	LV MCC	PU2333	Slop Oil pump	1.87	2.2	415	3	3.3	19.51	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	75	9.4800	0.1007	3.23	0.78	19.35	4.66	OK	16	20s
8	LV MCC	PU 2322B	Soft water pump-Stand by	3.15	3.7	415	3	5.5	32.82	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	105	9.4800	0.1007	7.60	1.83	45.56	10.98	OK	16	20s
9	LV MCC	PU2321A	Lye/Simplex Metering Pump	1.28	1.5	415	3	2.2	13.30	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	100	9.4800	0.1007	2.94	0.71	17.59	4.24	OK	16	20s
10	LV MCC	PU2321B	Lye storage tank pump	1.87	2.2	415	3	3.3	19.51	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	100	9.4800	0.1007	4.31	1.04	25.80	6.22	OK	16	20s
11	LV MCC	PU2305	Feed Pump(Seperator)	6.38	7.5	415	3	11.1	66.52	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	4.62	1.11	27.63	6.66	OK	18	20
12	LV MCC	PU2332	Saop Stock Pump	1.28	1.5	415	3	2.2	13.30	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	110	9.4800	0.1007	3.23	0.78	19.35	4.66	OK	16	20s
13	LV MCC	MX2305	Mixer	6.38	7.5	415	3	11.1	66.52	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	4.62	1.11	27.63	6.66	OK	18	20
14	LV MCC	MX2308	Mixer	6.38	7.5	415	3	11.1	66.52	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	6.46	1.56	38.68	9.32	OK	18	20
15	LV MCC	CF2312	Separator	25.50	30	415	3	44.3	266.08	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	85	0.9300	0.0816	5.18	1.25	30.74	7.41	OK	22	32
16	LV MCC	BW2313	Blower	3.15	3.7	415	3	5.5	32.82	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	6.88	1.66	41.22	9.93	OK	16	20s
17	LV MCC	RV 2314	Rotary valve	0.31	0.37	415	3	0.5	3.28	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	65	9.4800	0.1007	0.47	0.11	2.82	0.68	OK	16	20s

Basis:

1. Overall derating factor k = k1 x k2 x k3 x k4

   K1=Rating factor for variation in air/ground temperature

   K2=Rating factor for depth of laying

   K3=Rating factor for spacing between two circuits

   K4=Rating factor for variation in thermal resistivity of the soil

2. LT Motors : Running Voltage Drop = 3%, Starting Voltage Drop = 15%

3. Cable type:

   TYPE 1: Al Conductor, XLPE Insulated, Armoured, PVC outer sheathed

   TYPE 2: Cu Conductor, XLPE Insulated, Armoured, PVC outer sheathed

4. Effect of Frequency Variation ± 5%

5. Combined Effect of Voltage & Frequency Variation ±10%

ASSIGNMENT-6

LT CABLES

CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No.	**Cable Route (From-To)**	**Type & Cable Size**	**Size of Cable (mm2)**	**No. of Cable**	**Overall Diameter of each Cable (mm)**	**Sum of Cable OD (mm)**	**Self Weight of Cable (Kg/Mt)**	**Total Weight of Cable (Kg/Mt)**	**Remarks**
1	LV MCC	4	16	1	21	**21**	3.95	**1**	
2	PU2315- VFD	4	16	1	21	**21**	0.37	**1**	
3	PU2315- VFD	5	1.5	1	15	**15**	3.95	**0.4**	
4	LV MCC	4	6	1	18	**18**	0.37	**0.7**	
5	LV MCC	5	1.5	1	15	**15**	3.95	**0.4**	
6	LV MCC	4	2.5	1	16	**16**	0.37	**0.5**	
7	PU 2314 -B- VFD	4	2.5	1	16	**16**	0.9	**0.5**	
8	PU 2314 -B- VFD	5	1.5	1	15	**15**	0.9	**0.4**	
9	LV MCC	4	10	1	18	**18**	2.9	**0.9**	
10	PU2305- VFD	4	10	1	18	**18**	1.2	**0.9**	
11	PU2305- VFD	5	1.5	1	15	**15**	1.2	**0.4**	
12	LV MCC	4	10	1	18	**18**	1.2	**0.9**	
13	LV MCC	5	1.5	1	15	**15**	1.45	**0.4**	
14	LV MCC	4	16	1	21	**21**	2	**1**	
15	LV MCC	5	1.5	1	15	**15**	2.4	**0.4**	
16	LV MCC	4	6	1	18	**18**	2.4	**0.7**	
17	BW2313- VFD	4	6	1	18	**18**	0.85	**0.7**	
18	BW2313- VFD	5	1.5	1	15	**15**	0.85	**0.4**	
19	LV MCC	4	2.5	1	16	**16**	0.85	**0.5**	
20	LV MCC	5	1.5	1	15	**15**	1	**0.4**	
21	LV MCC	4	6	1	18	**18**	0.85	**0.7**	
	Total			**21**		**357**	**33.91**	**13.2**	

Calculation		
Maximum Cable Diameter:	18	mm
Consider Spare Capacity of Cable Tray:	30%	
Distance between each Cable:	0	mm
Calculated Width of Cable Tray:	464	mm
	8354	Sq.mm
No of Layer of Cables in Cable Tray:	2	
Selected No of Cable Tray:	1	Nos.
	300	mm
Selected Cable Tray Depth:	50	mm
	150	Kg/Meter
	Ladder	
	15000	Sq.mm

Result		
Selected Cable Tray width:	O.K	
Selected Cable Tray Depth:	O.K	
Selectrd Cable Tray Weight:	O.K	Including Spare Capacity
Selected Cable Tray Size:	O.K	Including Spare Capacity
Required Cable Tray Size:	300 x 50	mm
Required Nos of Cable Tray:	1	No
Required Cable Tray Weight:	150.00	Kg/Meter/Tray
Type of Cable Tray:	Ladder	
Cable Tray Width Area Remaning	23%	
Cable Tray Area Remaning:	44%	

ASSIGNMENT-7

EARTHING CALCULATIONS INPUTS

	2
Maximum line-to-ground fault in kA for 1 sec	17
Earthing material (Earth rod & earth strip)	GI
Depth of earth flat burrial in meter	0.5
Average depth / length of Earth rod in meters	4.5
Soil resistivity Ω-meter	9
Ambient temperature in deg C	55
Plot dimensions (earth grid) L x B in meters	80
Number of earth rods in nos.	2

Earth electrode sizing:

Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_0 + T_m}{K_0 + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - RMS fault current in kA = 50 KA	17
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
K0 - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
17 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	138
Earth rod dia in mm	13
Earth rod dia (including 25% corrosion allowance) in mm	17

Earth flat sizing:

Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_0 + T_m}{K_0 + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419

K0 - Factor at oC	293

The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:

14 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	114
Earth flat area in mm	12
Earth flat area (including 25% corrosion allowance) in mm	15
Selected flat size W * Thk in sq mm	20

Rg - Grid resistance

Grid resistance can be calculated using Eq. 52 of IEEE 80

$$R_g = \rho \left\{ \frac{1}{L} + \frac{1}{\sqrt{20 \text{ x } A}} \left[1 + \frac{1}{1 + h \sqrt{20 / A}} \right] \right\}$$

ρ - Soil resistivity in Ω-meter=	9
L - Total buried length of ground conductor in meter	440
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	11200
Rg - Grid resistance	0.058

Rr - Earth Electrode resistance

Grid resistance can be calculated using Eq. 55 of IEEE 80

$$R_r = \frac{\rho}{2 \text{ x } \pi \text{ x } n_r \text{ x } L_r} \left\{ l_n \left[\frac{4 \text{ x } L_r}{b} \right] - 1 + \frac{2 \text{ x } k_1 \text{ x } L_r}{\sqrt{A}} \left(\sqrt{n_r} - 1 \right)^2 \right\}$$

ρ - Soil resistivity in Ω-meter, 16.96	9
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	4.5
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	11200
Rr - Earth Electrode resistance	3.30673

Grounding system resistance

Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:

$$R_s = \frac{R_g \text{ x } R_2 - {R_m}^2}{R_g + R_2 - 2R_m}$$

R_m - Mutual ground resistance between the group of ground conductors, R_g and group of electrodes, R_r in Ω. Neglected R_m, since this is for homogenous soil

Rs - Total earthing system resistance	0.057

The calculated resistance grounding system is less than the allowable 1 Ω value.